TREASURY DEPARTMENT

Public Health and Marine-Hospital Service of the United States

JX/13

PUBLIC HEALTH BULLETIN No. 42

DECEMBER, 1910

DISINFECTANTS, THEIR USE AND APPLICATION IN THE PREVENTION OF COMMUNICABLE DISEASES

BY

THOMAS B. McCLINTIC

Passed Assistant Surgeon, United States Public Health and Marine-Hospital Service

PREPARED BY DIRECTION OF THE SURGEON GENERAL

WASHINGTON

GOVERNMENT PRINTING OFFICE

1911

CANCELLED

Presented by

The Surgeon General

March 1911

22500457396

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DISINFECTANTS, THEIR USE AND APPLICATION IN THE PREVENTION OF COMMUNICABLE DISEASES.

[From the Hygienic Laboratory.]

By Passed Asst. Surg. THOMAS B. MCCLINTIC.

INTRODUCTION.

As is generally understood, disinfection is the destroying of disease-germs, thus rendering the organisms inert and harmless. Using the term in a broad sense it may be made, also, to include the destruction of disease-carrying insects, as the processes are usually carried out along the same general lines. The infective organisms of the communicable diseases are, with few exceptions, much more easily killed by disinfectants than are some of the common spore-bearing and highly resisting saprophytic bacteria usually present in all localities, but as nothing would be gained by carrying the operation to the extent of killing the latter class of nonpathogenic organisms, the process of disinfection is usually one of degree only; in other words, it is not necessarily carried to the point of complete sterilization. The specific germ of some of the infectious diseases, such as smallpox, scarlet fever, and measles, has not yet been positively demonstrated; nevertheless experience has proven that the infection of these diseases can be destroyed by the intelligent and proper use of disinfectants.

The question then naturally arises as to the best methods of accomplishing disinfection. The ideal disinfectant will in all probability never be found, and consequently there will always be encountered more or less antagonism against disinfection, for, as Rosenau[1] aptly states, "the stress of modern activities demands disinfection processes that are instantaneous in their action, all pervading in their effect, cheap, harmless, and free from any unpleasant odors that might offend the senses of the fastidious. Such perfect disinfectants are unknown. It requires time, money, and the expenditure of well-directed and intelligent energy to accomplish satisfactory disinfection."

[1] Rosenau, M. J.: "Disinfection and Disinfectants," 1902, p. 32.

If the claims for some of the numerous proprietary disinfectants offered for sale upon the market were actually fulfilled, the process of disinfection would be very much simplified, but unfortunately this is not true, and in order to insure efficient results it is necessary to fall back upon the use of the old standard disinfectants that have stood the test of time and are known to be trustworthy. It should be borne in mind, too, that with the advance in medical science disinfection as intelligently applied to-day is far more specific than it formerly was and that the shotgun methods of former years have gradually passed into disfavor.

Without any pretense to originality, it will be endeavored to give here, in a simple and concise manner, the best methods of using disinfectants, and the special application of these methods in the eradication and prevention of some of the infectious diseases, with the hope that it may be of service, particularly to those more or less unfamiliar with the methods and technique of disinfection. The methods of disinfection, particularly the simpler ones, will first be described and then their special uses and applications will be given.

PART I.

DISINFECTANTS.

Disinfectants are usually divided into the following general classes:

(1) Physical agents, including sunlight, dry heat, burning, boiling, steaming, electricity, etc.

(2) Gaseous, including formaldehyd, sulphur dioxid, chlorin, etc.

(3) Chemical solutions, including bichlorid of mercury, formalin, carbolic acid, tricresol, lysol, creolin, potassium permanganate, lime, chlorinated lime, the hypochlorites, etc.

With the exception of heat, sulphur dioxid is the only one of the above-mentioned disinfectants that is used to any extent as an insecticide, while other substances used for this purpose are hydrocyanic acid gas, pyrethrum, petroleum, etc. As the uses of the physical agents, particularly the different forms of heat, are more or less familiar to all, they will not be further discussed in this paper, but the other disinfectants will be considered.

Gaseous Disinfectants.

In determining the quantities of disinfectant substances to be used for gaseous disinfection, the cubic contents of the space to be disinfected is always estimated, and usually expressed in terms of a thousand cubic feet.

A room, each dimension of which is 10 feet, contains 1,000 cubic feet, and the cubic contents of any space can be determined by multiplying together the length, width, and height, expressed in feet, which will give the contents in cubic feet.

To prevent the escape of the gas from the inclosure to be disinfected, fireplaces, ventilators, cracks of doors and windows, and other openings can be stuffed with cotton, paper, cloths, etc., but they are best closed by pasting them up, for which purpose strips of newspaper and a paste made from flour can be used.

All articles to be disinfected should be well exposed to the action of the disinfectant, as the penetrating powers of all gaseous disinfectants are more or less limited, therefore they should either be hung up or otherwise freely exposed to the gas.

FORMALDEHYD.

For disinfection purposes formaldehyd gas is usually produced from the aqueous solution of the gas, the official (U. S. P.) name of which is "solution of formaldehyd." The common commercial name for it, however, is "formalin," and since this name has been used in designating one of the principal methods of producing the gas, namely, the "formalin-permanganate" method, the solution will be referred to under the name of "formalin" in this paper.

Formalin is supposed to contain 40 per cent of formaldehyd gas by volume, but from evaporation and deterioration it often falls short of this quantity, seldom containing more than 37 per cent of the gas. The gas, when used under favorable conditions, is one of the most powerful germicides at our disposal. In addition to its germicidal efficiency it has the unique advantage over most other disinfectants in that it is not injurious to the ordinary household furnishings. Furniture, carpets, wall hangings, paintings, wearing apparel, and fabrics, with the possible exception of some of the very delicate anilin colors and polished steel, are unaffected by long exposures to the action of this gas.

It acts quickly as a germicide, but its powers of penetration are limited, so that it is necessary to have articles freely exposed in order to insure thorough disinfection. On account of lack of penetrating power it is evident that formaldehyd gas can not be depended upon to disinfect mattresses, upholstered furniture, or articles of that class requiring deep penetration; consequently after exposing them to formaldehyd gas they should be either burned, boiled, steamed (under pressure), or soaked in a disinfectant solution in order to make sure of destroying all possible infection.

Unfortunately the germicidal powers of formaldehyd are markedly affected by climatic conditions. With the temperature and humidity of the ordinary summer in the United States its efficiency as a surface disinfectant is unquestioned, but when the temperature is about or below 50° F., or the moisture in the atmosphere is below 60 per cent of saturation, the efficiency of formaldehyd is very much reduced. The temperature and humidity being below the points stated, polymerization of a portion of the formaldehyd takes place and its power of penetration, which at best is only slight, is still further diminished. These effects of low temperature and humidity may in part be overcome in room disinfection by artificial heating and at the same time boiling water in the room, by sprinkling the floors with water, and also by using an increased quantity of formaldehyd.

Formaldehyd gas is useless as an insecticide and is practically never used for that purpose. Flies and mosquitoes are killed by it only after a long exposure to the gas in concentrated form. It is nontoxic to the higher forms of animal life, including man, but produces in

them an irritation of the respiratory, nasal, and ocular mucous membranes, thus causing coughing, sneezing, and "watering" of the eyes. Unless the exposure is prolonged these effects, however, are only temporary and pass off when no longer exposed to the gas.

Formerly formaldehyd gas was largely produced by means of generators, lamps, autoclaves, etc., methods requiring special apparatus and a certain amount of mechanical skill in operating, but those methods have now largely been supplanted by simpler ones which can be used in any household. In view of this fact the instrumental methods will not be dealt with in this paper, but the following methods of evolving the gas will be described:

(1) Formalin-permanganate method.
(2) Formalin-sheet-spraying method.
(3) Formalin-aluminum sulphate-lime method.
(4) Paraform.

Regardless of which method is used, everything should be in readiness before the disinfection process is started. All trunks and drawers should be opened and most of the contained articles hung up or otherwise exposed in the room, particularly if there is a possibility of their being infected. All cupboards, closets, and bookcases should be opened.

Fireplaces, ventilators, and cracks of doors and windows to be closed should, with the exception of the doors of exit, be closed before the disinfection process is started.

To get rid of the formaldehyd gas remaining after disinfection it is usually sufficient to open the doors and windows and allow it to blow out. Ammonia was formerly used to a limited extent for neutralizing the gas, but, as it often causes a portion of it to precipitate in the form of a powder, which, when heated or moistened, will again give off a certain amount of formaldehyd gas, ammonia is now seldom used for that purpose. Even when the formaldehyd is allowed to blow out the odor of the gas is often perceptible for several days following disinfection. This, however, causes no trouble or inconvenience.

After disinfection with formaldehyd the quarters can usually be occupied an hour or two after opening the doors and windows.

Formalin-Permanganate Method.

When formalin is poured upon crystals of permanganate of potash a vigorous reaction takes place, accompanied by strong ebullition of the liquid and sufficient heat to produce a large quantity of formaldehyd gas, water, vapor, etc. The time required for the reaction to begin, or at least to become apparent, varies from a few seconds to a minute or two, depending upon the temperature. The reaction is

apparently over in a few minutes and with proper proportions of substances the residue in the vessel is almost dry.

A convenient and efficient proportion to use is two parts of formalin to one part of permanganate, or in the proportion of a quart of the former to a pound (pint) of the latter. By using a greater proportion of permanganate than this, slightly more gas may be evolved from the formalin, but in addition to requiring an increased expenditure of permanganate the danger of fire is also increased, as formaldehyd gas in a comparatively dry state is inflammable. The increased oxidation resulting from the additional permanganate is therefore more liable to cause combustion of the gas than when the proportions are used as just stated.

For mixing the formalin and permanganate a large galvanized-iron pail is very suitable. Pots or earthen vessels, usually being thick, are not as suitable as thin pails, on account of absorbing much heat from the reaction. The pail, though, may be heated before mixing the formalin and permanganate. On account of the vigorous ebullition during the reaction a 10-quart pail should be used for mixing therein 10 ounces of formalin and 5 ounces of permanganate. Even then a few drops of the mixture may be thrown over, so that it is well to place the pail in a large tin pan or upon something to protect the carpet or floor. To prevent this sputtering over there is some advantage in using a pail with a flared top. As the process is attended with slight danger of fire, the reaction, which is quickly over, should be watched through a window or the pails placed upon a noninflammable surface.

With this method the formaldehyd gas is evolved so quickly and in such a large volume that it is unnecessary, in houses with well-fitting doors and windows, to paste up cracks unless only a portion of the house is to be disinfected and the remainder is to continue to be occupied.

Closets, drawers, trunks, etc., should be opened, and when everything is in readiness the permanganate is placed in the pail and the formalin poured over it. In disinfecting an entire house all inside communicating doors, halls, etc., should be opened and at least one pail placed in each room and hall, unless the rooms are very small. Large rooms may require more than one pail unless a pail proportionately large is used.

The quantity of formalin and permanganate to be used per 1,000 cubic feet of room space depends upon conditions. If the atmosphere is warm and humid 10 ounces of formalin and 5 ounces of permanganate is sufficient, while if it is dry and cold double these quantities should be used. The pails should be placed about in the room or rooms as stated and the necessary quantity of permanganate weighed and placed in them; the formalin for each pail should then be measured

into a wide-mouthed cup or vessel and placed by the pail in which it is to be used. Do not use narrow-necked bottles or the pouring will require too much time. Although the reaction of formalin with permanganate takes place quickly, by making preparations as advised one operator can " set off " a number of pails, there being nothing to do except to pour the formalin over the permanganate. Of course the mixing should begin in the rooms most distant from the door of exit.

The time of exposure—that is, the time the premises should be kept closed—should be at least two and, preferably, four hours. At the end of this time the doors and windows are opened and the gas allowed to blow out.

The cost of formalin is about $1.35 per gallon. The cost of permanganate of potash is about $0.16 per pound.

FORMALIN-SHEET-SPRAYING METHOD.

This is a very simple and inexpensive method of evolving formaldehyd gas from formalin, and when properly used under favorable conditions is efficient. Formalin, sheets, and a means of spraying the formalin upon the sheets, are all that are required in the way of appliances. The sheets should be hung up over a cord or line and allowed to hang at an angle of about 45°, and it is of advantage, too, to slightly dampen them with water before hanging them up, as the formalin will then be quickly absorbed and lessen its tendency to run off the sheets.

The formalin should be evenly sprayed upon the sheets, which can be done with any spraying device, a very simple one being a flower-watering pot provided with a sprinkler. The spraying should be done rather quickly, as the gas soon begins to be given off. The process should be carried out in each room. Not over 10 ounces of formalin should be used for every 30 square feet of sheet surface. The area of a sheet is found by multiplying its length by its breadth.

This method is particularly applicable where a long exposure may be allowed, as the gas is gradually given off and the percentage of formaldehyd remains comparatively high during a relatively long time. This method should not be used at temperatures below 60° F., as the formalin polymerizes on the sheets and very little gas is liberated. With fairly close-fitting doors and windows, pasting of cracks is unnecessary, unless a strong wind is blowing. However, large openings like fireplaces, openings into chimneys, ventilators, etc., should be closed either by pasting or with bunches of old rags.

As this method should be used only during warm months, 10 or 12 ounces of formalin for each 1,000 cubic feet of air space is sufficient.

The time of exposure should be from four to six hours. Open the doors and windows and, when possible, remove the sheets. The sheets are not injured in any way by the formalin.

FORMALIN-ALUMINUM SULPHATE-LIME METHOD.

In this method 2½ pounds of commercial aluminum sulphate are dissolved in 2 quarts of hot water and allowed to stand for a few hours. To 1 quart of this solution, 3 quarts of formalin are added. To evolve formaldehyd gas from this later solution it is poured over unslaked lime in the proportion of 10 ounces of the solution to 1 pound of lime. Just before using the lime it should be broken into small particles. It should slake easily in cold water. The lime should be placed in a pail or vessel and the solution poured over it. A few minutes after pouring the formalin-aluminum sulphate solution over the lime, the latter begins to slake and continues for 20 to 30 minutes during which time formaldehyd, steam, etc., are given off. The percentage of formaldehyd gas liberated by this method is relatively small as compared with the formalin-permanganate method, but since a small quantity of formaldehyd is efficient when used under favorable climatic conditions this method will then give efficient results. This method, though, should *not* be used in cold, dry weather.

About 15 ounces of formalin-aluminum sulphate solution, made as described above, and 1½ pounds of lime should be used for each 1,000 cubic feet of air space. Cracks should be pasted up and fireplaces and ventilators closed, as the percentage of gas given off is relatively small. The time of exposure should be from four to six hours. The process should be carried out in each room.

This method of evolving formaldehyd gas has no advantages, but several disadvantages, as compared with the formalin-permanganate method, and is now seldom used. It is not as efficient as the sheet-spraying method.

The cost of formalin is about $1.35 per gallon and of aluminum sulphate about $0.15 per pound. The cost of unslaked lime, when available, is usually very small.

PARAFORM.

Paraform can be used, particularly for disinfecting small inclosures, under the same conditions of heat and moisture as already stated with regard to the other methods.

Paraform is one of the polymeric forms of formaldehyd. It is a white powder and readily burns with a blue flame. For disinfecting purposes it should be heated to convert the paraform into formaldehyd gas, but *under no condition* should it be allowed to burn, as the combustion destroys practically all of the formaldehyd. A good method of producing formaldehyd gas from paraform is to place the paraform in a metal utensil under which a lamp or alcohol flame can be placed. A special lamp or device can be obtained for the purpose, but an ordinary pint tin cup will suffice for heating therein an ounce

or two of paraform. The paraform is placed in the cup and a flame applied underneath. The flame should not be too strong, for should the paraform ignite no formaldehyd gas will be produced and there will be no disinfection. The space to be disinfected should be tightly closed and all cracks pasted up. For each 1,000 cubic feet of air space two ounces of paraform should be used. The time of exposure should be about four hours. If necessary, the flame under the utensil containing the paraform can be left burning during the time of exposure.

A solution of paraform can be made and used in the same manner that formalin is used in the formalin-permanganate method. For disinfecting 1,000 cubic feet of space 2 ounces of paraform are dissolved in 8 ounces of boiling water. This solution is then poured over 5 ounces of permanganate of potash contained in a 2-gallon pail, the details of procedure being the same as have been described for the formalin-permanganate method.

There are many forms of candles and other preparations of paraform made and sold upon the market for disinfection purposes, but bear in mind that any preparation of paraform requiring that the preparation be ignited and burned in order to produce formaldehyd gas is useless for disinfection purposes, as the formaldehyd is destroyed by the combustion.

In using those preparations of paraform that are heated to produce the gas, due allowance must be made for other ingredients than paraform contained therein, and therefore a larger quantity should be used than when using pure paraform, as at least 2 ounces of paraform should be used for each 1,000 cubic feet of space to be disinfected. For the reasons stated the use, for disinfection purposes, of proprietary preparations of paraform of unknown strengths should as far as possible be avoided.

SULPHUR DIOXID.

In the presence of moisture sulphur dioxid is an efficient surface disinfectant. Its powers of penetration are limited and it will not kill spores, but when used under favorable conditions it will kill the contagion of most of the infectious diseases not due to spore-bearing organisms. Dry sulphur dioxid (SO_2) is practically without germicidal powers, but in the presence of moisture this gas is converted into sulphurous acid gas (SO_3) and sulphuric acid (H_2SO_4), upon which efficient disinfection with sulphur gas depends. While these converted products are destructive to germ life, they are also injurious to household furnishings, fabrics, etc., which is one of the greatest drawbacks to the use of sulphur gas as a disinfectant. These injurious effects and the feeble germicidal properties of the gas in the dry state, have greatly limited its uses, particularly in household disinfection, but it is still especially applicable for destroying rats, flies, fleas, and other vermin that spread contagion, since it is highly

fatal to animal life. It is, therefore, applicable and largely used for disinfecting holds of ships, stables, barns, granaries, freight cars, and structures of this character. Sulphur, either as flowers or in rolls or sticks, can usually be obtained at any drug or crossroads store.

In the presence of moisture sulphur dioxid attacks and causes oxidation of most of the metals, which, however, can be prevented by previously vaselining the exposed surfaces; it bleaches and injures cotton, linen, and woolen fabrics, curtains, etc.; it injures flour, except in the closed ("headed up") barrel; it softens paint and varnish, particularly if they have been recently applied; it injures soap, coffee, tea, sugar, rice, matches, etc., when they are freely exposed to it; it injures clocks; and it discolors wall paper if moisture is present.

The moisture necessary in destroying germ life with sulphur dioxid can usually be artificially produced without difficulty, as it can be added in the form of steam (sulphur furnace), and in the pot method it is automatically produced from the water in the pan in which the sulphur pot is placed. However, when using sulphur dioxid as a disinfectant in damp weather or in disinfecting holds of ships which are usually damp, the artificial production of moisture is unnecessary.

The inclosure to be disinfected with sulphur gas should be made as tight as possible, therefore the cracks of doors, windows, and keyholes should be pasted up; fireplaces, ventilators, radiators, and all openings should be tightly closed, either by pasting them up or in some other manner. This should all be done, except the door of exit, before starting the disinfection. For pasting, strips of paper and a paste made from flour can be used. After the disinfection is over, the pastings can be moistened with water and washed off. It is necessary, to avoid injury to the articles enumerated above, to remove them from the space to be disinfected. Brass or any metal furnishings are not injured, provided they are given a thin coating of vaseline.

The principal methods of using sulphur dioxid are:

(1) The pot method.
(2) Liquid sulphur dioxid.
(3) Sulphur candles.
(4) Sulphur furnace.

Owing to the special apparatus required, the sulphur furnace will not be dealt with in this paper.[1]

[1] Passed Asst. Surg. Norman Roberts is now perfecting, at the Hygienic Laboratory, a portable stove for burning sulphur in the production of sulphur dioxid gas. The great advantage of the stove is that it burns the sulphur and produces the gas much faster than do any of the other methods described. The stove consists of several pans, which furnish a relatively large area for burning the sulphur, and as the pans are placed the one above the other in inverse step fashion, viz, the pans at the top are broader than those at the bottom, the heat from the pans beneath assist in heating the pans above. With equal burning surfaces, this stove burns the sulphur apparently three or four times as fast as it is burned by the pot method. The stove is very cheap and, depending upon the size, varies in weight from about 5 to 40 pounds.

THE POT METHOD.

This is the cheapest and simplest method of producing sulphur dioxid. The only materials required are pots, sulphur, and a small quantity of alcohol. Sulphur burns when liberally sprinkled with alcohol and lighted. It can also be started burning by placing a shovelful of hot coals of fire into it. As sulphur dioxid is produced by combustion of the sulphur, and as the combustion is dependent upon the available oxygen of the air, it will readily be seen that the rapidity of production of the sulphur gas will be governed by the area of the burning surface. It is therefore very important for rapid production that broad shallow pots be used.

Ordinary "Dutch ovens," iron buckets, etc., may be used, but the best pot for the purpose is one with a flat bottom, 12 to 18 inches in diameter, and with sides about 4 inches high. A dishpan answers the purpose very well.

Theoretically, the complete combustion of 1 pound of sulphur in a space of 1,000 cubic feet produces 1.15 per cent of sulphur dioxid, though 1 per cent is about what is produced in actual practice. Therefore, as 5 per cent is required to kill nonspore-bearing organisms, it is necessary to burn 5 pounds of sulphur for each 1,000 cubic feet of space to be disinfected.

After estimating the cubic space to be disinfected the sulphur should be weighed, allowing 5 pounds for every 1,000 cubic feet of space.

Sufficient pots should be available so that a depth of not more than $1\frac{1}{2}$ to 2 inches of sulphur will have to be placed in each pot, although necessity sometimes requires a greater depth than this. The sulphur should be sloped toward the center so as to form a crater or depression in the center.

When using stick sulphur a portion of it should be pulverized or broken up. The pots should be distributed in the rooms to be disinfected according to the size of the rooms and number of pots. They may be placed upon the floor, tables, stoves, hearths, etc.

It should be borne in mind that the burning sulphur causes the pots to become very hot, and to avoid danger from fire it is necessary to place them upon objects not combustible or injured by heat. As already stated, this is best accomplished by placing them in pans containing an inch or two of water, as, besides the protection, the heat produces moisture from the water, which is necessary in sulphur disinfection. Pans not being available, the pots may be placed upon earthen or metal surfaces and efficient disinfection done, provided the atmosphere is reasonably damp. Theoretically, about 3 ounces of water should be volatilized for each pound of sulphur burned. The sprinkling of the sulphur with alcohol and lighting

should not be done until everything is in readiness. A convenient and safe method of lighting the alcohol in the pots is to strike a match and before the head is entirely ignited to throw it into the pot. This will cause the alcohol to ignite. After lighting, the sulphur fumes do not begin to come off for a few minutes, so that one operator can start a number of pots. After lighting the pots, observe that they are all burning; then close the door of exit and paste up its cracks.

When the sulphur has been burning half an hour, search for sulphur fumes escaping from any openings that may have been overlooked and close them.

Leave the apartment or room closed for 12 hours, and then open doors, windows, etc., and allow the remaining sulphur fumes to blow out. It is well to have the windows so they can be opened from the outside, otherwise entrance to the rooms may be impossible for an hour or so. The rooms can usually be occupied in two or three hours after opening the doors and windows.

LIQUID SULPHUR DIOXID.

The technique of disinfection with liquid sulphur dioxid differs from the pot method only in the manner of production, therefore that is the only phase of the subject that will be described here, the reader being referred to the description already given for further details.

The method has the advantage of liberating a large quantity of sulphur dioxid in a short time, but it is a far more expensive method than burning sulphur by the pot method, the relative cost being about 10 to 1. The method of using liquid sulphur dioxid, however, is very simple and it is free from any danger of fire. The liquid is prepared commercially and is usually obtained in metal cans or casks, which for use only require the simultaneous cutting of the leaden pipes on the tops of the necessary number of cans and the inversion of the latter in a metal or earthen vessel, when volatilization rapidly takes place.

To obtain the 5 per cent of sulphur dioxid required for disinfection, it is necessary to use 10 pounds of liquid sulphur dioxid for every 1,000 cubic feet of air space. Therefore, the space should be estimated and the required quantity of liquid dioxid obtained. Of course, with this method the same preparations and precautions with regard to injury of certain articles should be carried out as with the pot method. If a number of adjoining rooms are to be disinfected, it is best to begin opening and inverting the cans in the most distant rooms and work toward the door of exit. It is necessary to have everything in readiness and to work quickly as the gas is given off rapidly. If the container of the liquid dioxid is provided with a

siphon or tube the liquid can be introduced by means of a tube through the keyhole into a suitable receptacle inside the room.

The time of exposure should be 12 hours.

One striking disadvantage of this method as compared with the pot method is that it produces no moisture, which is necessary to obtain the maximum disinfecting power of sulphur dioxid.

SULPHUR CANDLES.

As sulphur candles are applicable only for killing insects and not for disinfection purposes the method of using them will be described under sulphur as an insecticide.

CHLORIN.

Owing to its poisonous and destructive properties, chlorin is very seldom used as a disinfectant. Moisture is necessary for its action as a disinfectant, and in the presence of moisture it is also a powerful bleaching agent for all the organic pigments. Carpets, curtains, and fabrics generally are injured by its action. It is destructive to both animal and plant life. According to Rosenau [1] the most convenient method of generating the gas is by decomposing 1½ pounds of chlorid of lime with 6 ounces of strong sulphuric acid. This produces sufficient gas for the disinfection of 1,000 cubic feet of air space. Another method of generating chlorin gas is by adding four parts of strong hydrochloric acid to one part of magnesium dioxid. For practical purposes of disinfection, according to Munson,[2] free chlorin is much inferior to sulphur dioxid, since it is more difficult to control, more dangerous to manipulate, and more destructive in its effects.

Chemical Solutions.

BICHLORID OF MERCURY.

This substance is also known as corrosive sublimate, bichlorid, and mercuric chlorid. In the pure state it is a white crystalline substance and fairly soluble in water, thus differing from calomel (mercurous chlorid), which is a white amorphous powder and insoluble in water.

The "antiseptic tablets" sold on the market are usually composed of bichlorid of mercury. These tablets are generally artificially colored (blue) in order to lessen the chances of accidental poisoning with them, as bichlorid of mercury dissolved in water makes a perfectly clear solution.

Bichlorid of mercury is one of the most powerful germicides that we possess. It has the disadvantages, however, of corroding metals,

[1] Rosenau, M. J.: "Disinfection and Disinfectants," 1902, p. 142.
[2] Munson, "Military Hygiene," p. 786.

forming inert compounds with albuminous matter and of being very poisonous. It is therefore inadvisable to use it for disinfecting sputum, excreta, or under any condition in which it comes in contact with much albuminous or organic matter, since it forms inert compounds with these substances.

One part of bichlorid of mercury will dissolve in 16 parts of cold water and in three parts of boiling water. The bichlorid should be pulverized before attempting to dissolve it. Even then it dissolves with some difficulty. The solubility is increased by using sea water for the solution or by adding two parts per 1,000 of sodium chlorid (common salt) to the water employed. The water used should be free from organic matter and for dissolving the bichlorid it is preferable that the water be hot.

The strength of solution used in disinfecting for the infectious diseases is usually 1 part of bichlorid to 1,000 parts of water, viz, a strength of 1 to 1,000. This solution is made by dissolving 1 ounce of bichlorid in 1,000 ounces of water—approximately 8 gallons; a 1 to 500 solution is made by dissolving 1 ounce in 500 ounces of water, and so on for any other strength desired. The solutions are best made in an earthen or wooden vessel, a washtub or barrel being very suitable. The addition of a little indigo or other coloring matter will avoid the possibility of the solution being drunk by mistake.

To disinfect soiled clothing, bed linen, etc., they should be placed in a tub containing a 1 to 1,000 solution and left for an hour. They can then safely be taken out and rinsed in water and laundered. Bichlorid of mercury, however, is a mordant, and clothing containing stains, such as blood, etc., will be permanently stained if placed in bichlorid solution. Eating utensils should not be placed in bichlorid of mercury on account of the danger from poisoning. Infected floors, tables, wooden beds, chairs, walls, etc., can be washed with a 1 to 1,000 solution of bichlorid of mercury. For applying it, a floor mop may be used. Saturate the floors and other surfaces with the solution and allow them to dry. The hands and body, except the face, can be bathed in a 1 to 1,000 solution without injury thereto.

As already stated, feces, urine, sputum, and products containing albuminous matter should not be disinfected with bichlorid solution unless no other disinfectant is available, in which case a 1 to 500 solution should be used.

"Antiseptic tablets" are usually very soluble in water, and the method of obtaining the desired strengths is stated on the label of the container. They are very useful when only a small quantity of bichlorid solution is required. A 1 to 1,000 solution is easily prepared from them and is very useful for washing the hands after handling the sick or any possible infected material. The hands

should be bathed in the solution for two to five minutes after cleansing them with soap and water.

FORMALIN (SOLUTION OF FORMALDEHYD, U. S. P.).

Formalin, a solution of formaldehyd gas in water, is a valuable disinfectant. It has the advantage of bichlorid of mercury in that its action is not retarded by albuminous matter; it is not corrosive; articles are usually not injured by it; it is a good deodorant; and it is not so highly poisonous as is bichlorid of mercury.

Formalin contains from 35 to 40 per cent of formaldehyd gas, but in referring to percentage strengths the percentage of formalin will be stated and not that of the gas. For instance, a 1 per cent solution of formalin contains formalin in the proportion of 1 to 100, but it contains formaldehyd gas only in the proportion of 1 to 250, provided the formalin contains 40 per cent formaldehyd gas. Therefore, to make a 5 per cent solution of formalin, 1 volume of formalin is added to 19 volumes of water; and to make a 10 per cent solution, 1 volume of formalin is added to 9 volumes of water, etc.

Formalin is well adapted to the disinfection of urine, feces, sputum, and other discharges of like character, for in addition to disinfecting them, it also deodorizes them. For this purpose, according to Anderson,[1] a 5 per cent solution and one hour's exposure is required. They should be thoroughly mixed. Allowance must be made for the dilution caused by mixing the formalin solution with the material to be disinfected. For instance, if 1 pint of feces is to be disinfected it should be mixed with 1 pint of a 10 per cent solution of formalin, or a half pint of a 20 per cent solution, which in each case gives the 5 per cent strength required.

Formalin can not be used in the sick room, as the liberated gas is irritating; nor is it adapted to the washing of floors, walls, etc., for the same reason.

Soiled linen and bed clothing can be disinfected by one hour's immersion in a 5 per cent solution of formalin.

Disinfection with formalin should be done out of doors, in order to avoid the irritating effects of the gas given off.

A few drops either of pure or diluted formalin poured into water-closet bowls, urinals, sinks, etc., destroys offensive odors.

CARBOLIC ACID.

This is a very useful disinfectant. It has a penetrating odor, a strong burning taste, and it is a corrosive poison. Pure carbolic acid

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[1] Anderson, John F.: "The antiseptic and germicidal properties of solutions of formaldehyd and their action upon toxins,"—Bulletin 39, Hygienic Laboratory, United States Public Health and Marine-Hospital Service, Washington, 1907.

crystallizes and becomes solid at ordinary temperature, but it can be liquefied either by heat or by the addition of a small quantity of water, about 5 per cent.

Carbolic acid is soluble in about 15 parts of cold water; that is, 1 ounce of carbolic acid dissolves in 1 pint of water (16 ounces), which is about a 6 per cent solution.

Carbolic acid dissolves in water with some difficulty. Therefore, to insure its solubility, hot water should be used and the mixture well agitated.

For disinfection purposes carbolic acid is commonly used in solutions of 3 to 5 per cent. A 3 per cent solution is made by adding 3 volumes of carbolic acid to 97 volumes of water; a 5 per cent solution is made by adding 5 volumes to 95 volumes of water, etc.

In these strengths carbolic acid is not destructive to fabrics, colors, metals, etc. Therefore, it has a wide range of usefulness in disinfection. As it does not actively coagulate albuminous matter, it is useful for the disinfection of urine, feces, sputum, etc. For this purpose a 5 per cent solution is added to an equal volume of the excretions, the mass then thoroughly mixed and allowed to stand one hour before final disposal.

Soiled linen, bedclothes, etc., are best disinfected by immersion for one hour in a 3 per cent solution, and the same strength solution should be used for mopping floors, walls, etc. After handling the sick or any objects possibly infected, such as bedpans, sputum cups, etc., the hands may be disinfected by washing them for two to five minutes in a $2\frac{1}{2}$ per cent (1 to 40) solution of carbolic acid. The hands should then be washed or saturated with alcohol in order to avoid the benumbing effect of the carbolic acid. As carbolic acid does not kill spores it should not be used to destroy the infection of tetanus, anthrax or malignant œdema.

Crude Carbolic Acid, as sold upon the market, is a black, tarry liquid of very varying composition. It contains cresols and other compounds, but although some of these products have greater germicidal powers than pure phenol (carbolic acid), their solubility in water is so slight that the use of crude carbolic acid as a disinfectant is greatly limited. The reliability of crude carbolic acid is therefore questionable, and some sanitariums recommend that for excreta it be used in the proportion of not less than two volumes of crude carbolic acid (undiluted with water) to each volume of excreta.

Crude carbolic acid has a disagreeable odor, and leaves, after use, a tarry residue, which is objectionable. The crude article, however, is much cheaper than pure carbolic acid, and it is hoped that a simple means of increasing its solubility and of eliminating the objectionable tarry residue following its use, may soon be found, so

that it may at least be employed in the disinfection of urine, feces, sputum, etc.

TRICRESOL.

Tricresol has practically the same uses in disinfection as pure carbolic acid. It differs from it principally in that it is about three times as strong in germicidal powers as is carbolic acid. It, therefore, can be depended upon to kill spores. Tricresol is soluble in water up to about 2½ per cent solution; that is, 1 part of tricresol to 40 parts of water. A 1 to 2 per cent solution used under the same conditions and for the same purposes as already stated for carbolic acid is efficient for all ordinary purposes.

LYSOL AND CREOLIN.

These preparations have practically the same uses in disinfection as carbolic acid and tricresol, and belong to the same general class of disinfectants.

In germicidal strength they rank with tricresol. Their uses are the same as tricresol and carbolic acid which have been stated. They should be used in a 1 to 2 per cent solution.

POTASSIUM PERMANGANATE.

This is a germicide of undoubted power, but of very limited application in general practice on account of the readiness with which it is reduced and rendered inert by organic matter. Except in surgical practice its uses are largely limited to the disinfection of water tanks, cisterns, etc. For this purpose they are emptied of water and the interior thoroughly scrubbed with a 1 per cent aqueous solution of permanganate. After standing an hour or two they are washed out with water until the water comes away perfectly clear. Provided scrubbing of the tanks, etc., is impracticable, they may be filled with water and then enough of a strong solution of permanganate, made with boiling water, added to produce a dark rich purple color. After standing four hours, clean water should be added until the water in the tanks, etc., comes away clear. The tanks are then ready for use. Potassium permanganate is soluble in 16 parts of cold and 2 parts of boiling water. Stains produced by permanganate can be removed by washing in a solution of oxalic acid, lime juice, or vinegar.

LIME.

This substance is also known as quicklime and calcium oxid. It is cheap and when used properly is an efficient disinfectant. Lime may be used for the disinfection of feces, urine, sputum, and other

dejecta; it is useful for the disinfection of privies and for any condition under which the soil is suspected of being infected, as in cellars, mucky back yards, etc.; and it is also useful, when applied as whitewash, for the disinfection and sweetening of cisterns, cellars, barracks, barns, stables, poultry houses, etc.

It is necessary that the lime be obtained fresh and kept in the unslaked condition. As unslaked lime is often in large, stony masses, it should be sufficiently slaked by the addition of a little water to enable its being distributed for disinfection purposes. In then applying it there should be present only enough moisture to cause the slaking to be completed. This necessary moisture is present in urine, feces, sputum, etc., and is usually present in damp cellars, cisterns, privies, dairies, and back yards, it being required only that these localities be liberally sprinkled with the lime. For disinfecting feces, sputum, etc., they should be well mixed with an equal quantity of lime and allowed to stand for an hour or so before final disposal.

Air-slaked lime is practically inert as a disinfectant; therefore, care should be exercised to keep the lime from the air as much as possible before using it.

Milk of lime is a better disinfectant than lime. It is made by mixing, in a tub or bucket, fresh lime with four times its volume of water, the resulting mixture being ready for use. It is useful for disinfecting excreta, etc., to which it should be added in equal volume and allowed to stand for two hours before final disposal. Milk of lime is most powerful when first prepared. It therefore should be made and used fresh, unless it can be bottled or in some way protected from the air after it is prepared.

CHLORINATED LIME.

Chlorinated lime, or bleaching powder, popularly miscalled "chlorid of lime," according to Rosenau,[1] ranks with unslaked lime in power and value as a germicide, and has about the same uses in practical disinfection. It is a much better deodorant than lime.

As chlorinated lime deteriorates on exposure to the air, through the liberation of its chlorin, it should be kept in air-tight containers and preferably stored in a cool, dry place.

For disinfection purposes it may be used either as a powder or in solution. As a powder, it is applied in very much the same manner as lime. Cellars, privies, etc., are simply sprinkled with it, but not so liberally as when lime is used. It should be well mixed with urine, feces, sputum, etc., in sufficient quantity to form about 4 per cent of the entire mass.

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[1] Rosenau, M. J.: "Disinfection and disinfectants," 1902, p. 167.

Small quantities of chlorinated lime sprinkled in sinks, urinals, water-closet bowls, etc., will destroy foul odors.

By mixing 1 pound of good chlorinated lime with 4 gallons of water a *solution of chlorinated lime* is obtained which is very useful for disinfection purposes. With this solution floors may be mopped and the hands disinfected by washing them in it for a few minutes. Excreta and sputum are disinfected by thoroughly mixing them with equal volumes of this solution and allowing to stand for one hour.

Chlorinated lime corrodes metals, but the injury to agate ware, such as bedpans, is only slight. It bleaches and otherwise injures fabrics. The disagreeable odor resulting from the use of chlorinated lime in the sick room may be removed by hanging about in the room towels saturated with a strong solution of baking soda.

THE HYPOCHLORITES OF LIME.

As the active disinfection agent found in solutions of chlorinated lime is principally calcium hypochlorite, the uses of the hypochlorites are practically the same as the solution of chlorinated lime.

Labarraque's solution is an aqueous solution of several chlorin compounds of sodium, chiefly sodium hypochlorite and sodium chlorid.

It may be diluted with twice its volume of water and used for the same purposes and in the same manner as the solution of chlorinated lime.

PART II.

INSECTICIDES.

An insecticide is a substance that destroys insect life.

There are many ways and methods of doing this, but only the simple methods of using the common insecticides, as applied to disinfection against the insect-borne diseases, will be dealt with here.

Attention will therefore be paid principally to the destruction of flies, fleas, mosquitoes, roaches, bedbugs, lice, rats, mice, etc. The destruction of insect life and disinfection are often accomplished simultaneously in the process of disinfection, as most germicides are also insecticides, a notable exception to this being formaldehyd gas, which, although a good germicide, has little or no effect upon insect life. Therefore, in using gaseous germicides (disinfectants) as insecticides, they are applied in much the same manner when used for the latter as for the former purpose.

However, when using them for the destruction of insect life only they are usually used in a weaker strength and for a shorter time of exposure than when they are used for their germicidal effect.

In using gaseous insecticides every care should be exercised to avoid the escape of the insects from the enclosure during the process of killing them; consequently all points of possible exit should be closed. Closets, bookcases, drawers, etc., likely to harbor or contain them, should be opened to allow access of the gas.

The following insecticides will be considered:

(1) Sulphur.
(2) Hydrocyanic acid gas.
(3) Pyrethrum.
(4) Petroleum.

SULPHUR.

Sulphur is one of the most valuable and efficient insecticides that we possess. It may be used in several forms.

SULPHUR DIOXID.

The methods of producing this gas have already been described, therefore further description here will consist only of the differences between its uses and applications as an insecticide and those as a germicide.

As an insecticide sulphur does not require the presence of moisture, since it acts equally as well in a dry as in a moist atmosphere. Therefore, moisture should not be artificially produced, as the drier the atmosphere the less the injury there will be to furnishings, colors, etc.

With all cracks and crevices closed to prevent their exit, a 1 per cent strength will kill flies and mosquitoes within two hours; and if the atmosphere is reasonably dry, very little injury will be done to the ordinary room furnishings.

A 2 per cent strength will kill rats within four hours, and a 5 per cent strength will destroy most bedbugs, roaches, lice, etc., within six hours, although some of these insects usually escape by seeking protection in crevices, etc. To obtain the desired strength of sulphur gas it is only necessary to remember that the burning of 1 pound of sulphur in 1,000 cubic feet of space produces approximately 1 per cent of the gas, 2 pounds 2 per cent, etc.

The pot method of production has already been described. In order to burn the sulphur quickly it should not be placed in the pots to a greater depth than an inch. Water pans are not required, but the pots should be placed upon bricks, sand, stones, or something of that nature as a protection against fire. The pots are arranged and lighted with alcohol as has been described.

Liquid sulphur dioxid is well adapted to the destruction of insect and vermin life, as the gas is liberated in a short time. Two pounds of the liquid are equivalent to 1 pound of sulphur when burnt by the pot method. The method of liberating the gas has been described.

Sulphur candles are sometimes useful for killing flies and mosquitoes, or where only a small percentage of the gas is required. Candles vary in weight, but their weight should be determined, and for killing flies and mosquitoes not less than 1½ pounds of candle should be used for each 1,000 cubic feet. The candles require only to be placed upon bricks and lighted; they usually burn easily. The usual time of exposure, two hours, is required.

FLOWERS OF SULPHUR.

Sulphur in the powdered state may be used as an insecticide, but it must be directly applied to the insects, and is used principally for the destruction of mites, lice, etc. It has but a limited use against bedbugs, ants, roaches, etc., and is useless against the winged insects.

BISULPHID OF LIME.

This is a good insecticide where a liquid is applicable. According to Rosenau [1] it may be very cheaply prepared by boiling together for an hour or more, in a small quantity of water, equal parts of flowers of sulphur and stone lime. A convenient quantity is pre-

[1] Rosenau, M. J.: "Disinfection and disinfectants," 1902, p. 185.

pared by taking 5 pounds of sulphur and 5 pounds of lime and boiling in 3 or 4 gallons of water until the ingredients form a brownish liquid. This may be diluted to make 100 gallons. It is applied in the form of a spray or poured into cracks and crevices infested with bedbugs, lice, roaches, etc.

HYDROCYANIC ACID GAS.

This gas is very poisonous to all forms of animal life. It kills rats, mice, roaches, flies, fleas, mosquitoes, and bedbugs with great certainty and very quickly. In the hands of the inexperienced it is a very dangerous gas, as the least carelessness with it may result in the loss of human life, since it is deadly poisonous. It is therefore unsafe and unwise to use it in inhabited buildings, but it is useful for destroying all forms of vermin in granaries, stables, barns, poultry houses, etc. For this purpose it is used in the following quantities and proportions for each 1,000 cubic feet of air space:

Potassium cyanid	1 pound.
Sulphuric acid	1.5 pints.
Water	2.25 pints.

The acid and water are first mixed in an earthen vessel that will withstand heat, as this mixture gets very hot. The cyanid should not be added to it until the liquid has become cool. The required quantity of cyanid should be weighed and put into a gauze bag, and when everything is in readiness the bag is placed in the liquid contained in the vessel. The acid destroys the bag and acts on the cyanid with rapid evolution of the gas; and as the gas is deadly poisonous, the operator must leave the room at once.

A still safer method of adding the cyanid to the acid than the one just stated is to have the bag of cyanid supended over the acid by means of a string leading to the door of exit, from which location it can be lowered into the acid when desired. In this manner one or more processes can be set off without danger to the operator.

The inclosure should be made as tight as possible to avoid the escape of the gas. The time of exposure should be six hours, though a longer time will minimize the danger from the gas in opening the doors and windows. It should be arranged before starting the process, so that the windows and doors can be opened from the outside, and it is best to hold the breath while actually opening a door or window. Under no condition should the building be entered until it has been aired out from 8 to 10 hours.

PYRETHRUM.

Pyrethrum is only a fairly good insecticide. It is not poisonous to man, nor are household furnishings of any kind injured by it. Unfortunately, it is not very powerful for the destruction of roaches.

flies, fleas, and mosquitoes. Some of these insects are killed, while some are only stupefied, by pyrethrum, so that it is necessary, after using it, to sweep the insects up and burn them.

Pyrethrum may be used either in powdered form or as the fumes resulting from burning it. Persian and other insect powders sold upon the market usually contain pyrethrum in some form. As a powder it may be blown about in the closed room with a bellows in sufficient quantity to show perceptibly upon the floor, or it may be dusted into cracks, crevices, dark corners, closets, or special localities likely to be infested with mosquitoes, fleas, bedbugs, etc. After two hours' exposure the insects should, when practicable, be swept up and burned.

In burning pyrethrum for killing flies and mosquitoes the room should be closed as tightly as possible. In killing these insects in dwellings it is well to pull down all window shades except one, as the insects will then go toward the light of the window the shade of which is not drawn, and when they die or become stupefied they can be easily swept up. Pasting of door and window cracks is usually unnecessary.

From 2 to 4 pounds of pyrethrum should be burned for every 1,000 cubic feet. The pyrethrum is burned in pots, pans, or iron buckets in the same manner that sulphur is burned in the pot method. The pots should be used in sufficient numbers so that not more than 4 pounds of pyrethrum will have to be placed in each pot. They should be distributed about in the room upon metal or stone foundations in order to guard against fire.

The pyrethrum is started burning by sprinkling it with alcohol and lighting it. After the alcohol has burnt, the pyrethrum smolders and burns, thus liberating the fumes.

The time of exposure is usually 2 hours, although when working at night the quarters may be left closed until the following morning. As stated, the insects should be swept up and burned as soon as the quarters are opened. Both the fumes and the powdered form of pyrethrum are harmless to man, so there is no danger in entering quarters as soon as they are opened.

PETROLEUM.

Petroleum is also known as kerosene, coal oil, lamp oil, etc.

It is a valuable insecticide but of limited application, as it must be applied in liquid form. Its principal use as an insecticide is in the extermination of mosquitoes. As is well known, mosquitoes usually breed in standing water, such as pools, ponds, puddles, cisterns, rain barrels, etc. The female mosquito lights and lays her eggs upon the water, the eggs hatch, and the young mosquitoes then

live in the water in the form of "wrigglers" until they reach maturity. It is necessary for "wrigglers" to come to the surface of the water every few minutes to breathe; therefore with even a thin film of petroleum upon the water the oil gets into their breathing apparatus and kills them. Likewise the female mosquito is usually killed when she lights in the film of oil to lay her eggs. Mosquitoes breed only in water; they do not breed in wet grass, manure, etc., unless there is sufficient water upon which the eggs may float and in which the "wrigglers" can swim. Therefore to stop the breeding of mosquitoes it is necessary only to cover the water with a thin film of petroleum. When petroleum is poured into water it spreads and forms a thin film over the surface. It is applied at the rate of 1 ounce of petroleum to 15 square feet of water surface. It should be renewed at least once a week or oftener, depending upon conditions which are apparent in any given case.

By having the outlet for water in barrels, cisterns, ponds, etc., below the surface the running away of the oil may be prevented, and water obtained for use free from oil. Petroleum is also useful against roaches, bedbugs, and other forms of insect vermin. For this purpose the pure oil may be directly applied, or it may be used in the form of a spray.

Gasoline is a very useful and efficient insecticide for bedbugs and lice. In the liquid form it can be liberally poured into the cracks and crevices of beds, floors, walls, chairs, etc., infested with these insects. Even when gasoline is poured upon a papered wall it soon evaporates without injury to the paper. The strictest precautions, however, must be taken against fire, as gasoline is highly inflammable. Therefore the presence of fire or the lighting of a match in the vicinity where gasoline is being used, must be prohibited.

PART III.

THE APPLICATION AND USE OF DISINFECTANTS AND INSECTICIDES IN THE ERADICATION AND PREVENTION OF COMMUNICABLE DISEASES.

There are already a large number of diseases known to be communicable, and the list is still increasing as time goes on and new discoveries are made.

As communicable diseases are preventable, this, then, is the day of preventive medicine, and a large share of the responsibility naturally falls upon the medical profession, particularly the health authorities. Their work, however, would be very much handicapped and often go for naught without the aid of the general public; therefore it must do its part, and its part is no small one.

A knowledge of medicine is not always necessary in order to conform to the simple rules of hygiene and intelligently to apply the use of disinfectants in the prevention of communicable diseases. "Communicable," "infectious," and "contagious" are terms that have become more or less synonymous in their meaning, and are often used interchangeably to convey the same idea in referring to the transmission of disease.

A thorough understanding—which at present is lacking—as to the exact nature of the cause and methods of transmission of some of the communicable diseases might make it possible to inaugurate for their prevention more effective and probably simpler methods than those at present in use.

In the case of many of the communicable diseases, however, the specific organism is known and its modes of transmission are understood; with others the specific germ is known, but its modes of transmission are not at all or only poorly understood; with others the organism has not been identified, but its modes of transmission are at least fairly well understood; while with still others the specific organism or cause is still unknown and its ways of transmission are only vaguely understood. Furthermore, some of the communicable diseases are transmitted through the agency of insects acting as simple carriers of the infection; others through insects as intermediate hosts; and others through food, drink, contamination of the air, contact, and various other ways.

It is evident that the uses and application of disinfectants and insecticides in the prevention of all the communicable diseases is a large subject, and to take up each disease in detail would reach far beyond the limits of this article. Therefore, as some diseases call for the same general hygienic management and preventive measures, the one most typical of the class will be described, and the remaining ones of that class described only in so far as they may differ from the one described as typical. For instance, the prophylactic measures that should be carried out against typhoid fever are very much like those that should be used against cholera, dysentery, etc., and, therefore, typhoid will be taken as typical of the class; likewise smallpox will be described as typical of the exanthemata, others of which are scarlet fever, measles, chicken pox, etc.

It should be borne in mind that, after all, disinfection is a more or less relative process and that it can but seldom be made absolute, particularly in so far as the infection of the communicable diseases is concerned. Patients suffering with some of the communicable diseases are constantly eliminating the infection from their systems and to disinfect all the infection thus eliminated is well nigh impossible. Nevertheless, most of it can be destroyed by the intelligent use of disinfectants, thus reducing to a minimum the danger of the infection being spread.

(1) TYPHOID FEVER—CHOLERA—DYSENTERY.

TYPHOID FEVER.

Typhoid fever is a communicable disease caused by the *Bacillus typhosus*, a germ so small that it can not be seen except with a microscope.

The germs are contained in enormous numbers in the feces, usually in the urine, and often in the sputum of typhoid patients. Typhoid fever is always contracted by taking these germs into the body, through the mouth, either with the food, drink, or otherwise.

A small particle of typhoid excreta, even what will adhere to the legs of a fly, may contain the typhoid organism in large numbers. It is easy then to understand how flies and other insects may spread typhoid infection. They light upon the feces, urine, sputum, or even the lips of the patient; they then may infect food and drink by lighting upon it, or they may carry the infection direct to healthy persons.

The fly, therefore, should be rigidly excluded from the sickroom and from the whole house if possible by screening; fly paper or fly poison should be exposed in the sickroom to kill any that may by chance gain entrance thereto. During certain seasons of the year

the fly may not be present, but under no condition should excreta of typhoid patients be exposed to flies, at least until it has been thoroughly disinfected. The disinfection should, therefore, be done in a fly-proof inclosure.

The sickroom should have a bare floor, so that it may be washed with a disinfectant from time to time and whenever it may be soiled with the patient's excretions; unnecessary furniture should be excluded from the room; a basin containing a 1 to 40 solution of carbolic acid or a 1 to 1,000 solution of mercuric chlorid should be in readiness for the doctor's and nurse's hands. A cup or glass containing a 1 to 40 solution of carbolic acid for the thermometer should be on hand, and the thermometer should be kept entirely submerged in the solution when not in use; one or more bedpans should be available, and there should be on hand a supply of disinfectants, as well as some buckets or vessels in which to prepare the disinfectant solutions.

Special gowns for those attending the patient may be used, but they are not necessary, provided intelligent care is exercised. The nurse, however, should wear a rubber apron when bathing the patient, and it should be frequently washed in 3 per cent carbolic acid. Visitors and others not required in the sick room should be excluded.

Disinfection and disposal of excreta.—Feces, urine, sputum, and all discharges from a typhoid fever patient should be disinfected as soon as they leave the patient.

This is economically and efficiently accomplished by having a jar, bucket, or pan large enough to hold several times the volume of the excretions voided in 24 hours. It is placed convenient to, but not in the sick room, and not accessible to flies. The urine, feces, etc., are placed in it when they are voided, and a volume, equal to, or greater than the volume of excretions, added to it of one of the following solutions:

Solution of chlorinated lime (p. 23).

Milk of lime (p. 22).

Solution of carbolic acid, 5 per cent.

Solution of formalin, 10 per cent.

The bedpan is rinsed with the disinfectant solution and it then should be immersed for 10 minutes in one of the above solutions, contained in a suitable vessel, as it must be remembered that the outside of the bedpan may be infected by coming in contact with the patient. Bedpans may also be disinfected by sprinkling them with a strong solution of formalin and then simply covering them with a heavy cloth for 15 to 20 minutes. On account of the formaldehyd gas given off this will have to be done out of doors.

In the above manner the entire excretions of a patient for a day can be disinfected and disposed of in sewers, water-closets, privies, etc., without danger of spreading the infection.

Chlorinated lime (powdered form), if used for disinfecting excreta, should be thoroughly mixed with the excretions in sufficient quantity to form 4 or 5 per cent of the entire mass. Likewise, lime used for the same purpose should be added in volume equal to that of the excretions.

When it is impracticable to disinfect the excretions for 24 hours, as stated above, bear in mind that excretions from typhoid patients should not be finally disposed of until they have been exposed to the action of the disinfectant for at least one hour, and under no condition should the excretions be disposed of without disinfection.

The typhoid germ is rather easily killed by heat; therefore in rural districts when disinfectants are not available or only in very small quantities, typhoid excreta can be disinfected with boiling water. In this case the excretions may be sufficiently disinfected to render them safe by filling the bedpan containing the excretions with actually boiling water and allowing it to stand until cool; the contents of the pan are then disposed of, preferably by burying, and the pan rinsed (scalded) with boiling water. Of course the excretions may be disinfected by boiling them in a vessel located in the back yard or some other suitable place. The bedpan though, after it is emptied, should be placed in boiling water for a few minutes.

The preventive measures outlined above should be kept in force, with regard to the urine and feces of typhoid patients, for two or three weeks after recovery, as these excretions may contain the typhoid organism for a considerable time after convalescence. Typhoid excretions should *never* be disposed of where they may get into the water supply, even though they have been disinfected.

Disinfection of the hands.—After handling the patient, bedpan, soiled linen, or any possibly infected material, the hands should be washed for at least two minutes in one of the following solutions:

Bichlorid of mercury	1 to 1,000
Carbolic acid	1 to 40
Tricresol	1 to 100
Lysol	1 to 100

After washing the hands in any one of the last three solutions they should be rinsed in alcohol to avoid the benumbing effect of these solutions. Persons engaged in handling and managing typhoid-fever patients should avoid, as far as possible, placing their hands about their own faces, and they should invariably wash their hands in one of the above disinfectant solutions before eating their meals.

Disinfection of soiled linen, bed clothing, eating utensils, etc.—Soiled linen, towels, bedclothes, etc., are best disinfected by boiling

them for a few minutes. They may also be disinfected by one hour's immersion in a 3 per cent solution of carbolic acid or a 1 per cent solution of tricresol, etc.

Eating and drinking utensils, after being used by the patient, should be washed in boiling water. They should not be used by others, at least until they have been sterilized by boiling.

Disinfection of the bath water.—The water used in bathing the patient may undoubtedly be infected by the patient's excretions. The ordinary bath of 50 gallons of water may be disinfected by mixing in it half a pound of chlorinated lime and allowing it to stand for half an hour before disposing of it.

Terminal disinfection.—Gaseous disinfection of the room after convalescence, death, or removal of the patient is not always necessary, but it is advised as a measure of safety against any possible infection that otherwise might escape disinfection. It is therefore recommended that formaldehyd gas be used, as described on page 9.

The floor, walls, tables, bed, chairs, etc., should be washed with a disinfectant solution, particularly if gaseous disinfection is omitted. The bed clothing, pillows, linen, etc., should be treated as already described. Without the use of a steam chamber the disinfection of mattresses is a difficult and uncertain problem. Therefore, it is far better that they be burned.

It may be well to state here that during the prevalence of typhoid fever in a house or community it is well to drink only boiled water, and either to avoid drinking milk or drink it only after it has been heated to the boiling point.

Bear in mind, then, that the watchword in typhoid-fever prevention is to *disinfect the excretions as they leave the patient, and to avoid taking living typhoid germs into the body in the food, drink, or otherwise, for without taking these germs into the body through the mouth there will be no typhoid fever.*

CHOLERA.

Cholera is a communicable disease due to the *Vibrio choleræ asiaticæ* or, as it is often called, the "comma bacillus." The disease is sometimes called Asiatic cholera, on account of its home in India, and to distinguish it from cholera nostras, cholera morbus, and other forms of noncommunicable affections with choleraic symptoms.

The feces always, and the vomit frequently, of those having the disease contain the germ in great numbers. They, however, are not found in the urine.

The germs are conveyed from sick to healthy persons and the disease thus contracted in almost the identical way as is typhoid

fever. The reader is therefore referred to the description of typhoid fever given above for the details of disinfection and other preventive measures to be carried out against cholera.

DYSENTERY.

Dysentery is a communicable disease occurring in epidemic form, especially in the tropics or during the hot season of the year. It is sometimes called "epidemic dysentery" to distinguish it from "amebic dysentery." Dysentery is caused by the *Bacillus dysenteriæ*, a minute bacterial organism, while amebic dysentery is believed to be due to the *Entamœba histolytica*, an organism belonging to the animal kingdom and rather resembling in appearance a white blood cell. The former, then, is due to a bacterium, the latter to a protozoon. The two diseases, however, are contracted in very much the same manner, namely, by taking the organisms into the body through the mouth, usually with the food and drink.

The feces of patients having either one of these diseases contains the specific organism in large numbers. Therefore what has been stated with regard to the prevention of typhoid fever applies also to the prevention of both dysentery and amebic dysentery.

(2) SMALLPOX—SCARLET FEVER—MEASLES—CHICKEN POX—ERYSIPELAS.

SMALLPOX.

Smallpox is highly communicable, but the cause of the disease has not been discovered. The disease is often referred to as "contagious" because it is readily conveyed by contact between the sick and the well. The exact manner in which the virus of infection of smallpox is given off from the body of the patient is not definitely known, but it is thought to be thrown off from the body of the patient into the surrounding air, perhaps with the exhaled breath and certainly from the eruption, whether fluid or dried in the crusts.

The infection of smallpox is thought to enter the body through the respiratory tract.

The preventive measures to be carried out against smallpox are, briefly stated, *vaccination*, *isolation*, and *disinfection*.

Vaccination.—All persons should be vaccinated at least by the time they are a year old. If the vaccination does not "take" it should be repeated until it does "take." They should be vaccinated again about every five years or whenever they are exposed to smallpox. Persons continuously exposed to smallpox should be vaccinated at least once a year.

Isolation.—Whenever possible, smallpox should be treated in an isolation hospital provided for contagious diseases. Where this is not practicable, a room should be used that is isolated as much as

possible from the remainder of the building. The room, before being occupied by the patient, should be divested of all unnecessary furniture, hangings, draperies, carpets, etc. It should be capable of being darkened and freely ventilated. An adjoining room should be available for the use of the doctor and nurses, as well as for disinfection and other obvious purposes. There should be no communication with the patient except on the part of the necessary attendants, nurses, and the physician.

Disinfection.—Body clothing worn by the patient before taking to bed should be boiled or burned. All linen, garments, towels, etc., soiled or used by the patient should, as soon as they leave the patient, be immersed at least one hour in one of the following solutions:

Carbolic acid	5 per cent.
Tricresol or lysol	1 to 2 per cent.
Chlorinated lime	4 ounces to 1 gallon of water.

As a further measure of safety they should then be boiled, after which they may be laundered and again used, if desired.

Handkerchiefs or clothes soiled by secretions from the patient's nose and mouth had better be burned, though they may be disinfected, as stated above.

The urine and feces of smallpox patients are not supposed to contain the virus of smallpox, but since they may become infected either during or after they are passed by the patient they should be disinfected before disposing of them. They may be disinfected in any one of the ways described for the disinfection of typhoid excreta.

Eating utensils, medicine glasses, etc., used by the patient should be immersed in actually boiling water. Food that has been in the sick room, but not consumed, should either be burned or placed in boiling water. All disinfection should, as far as possible, be done in a room adjoining the sickroom; or, if that is not available, in the sickroom. The doctor or others temporarily entering the sickroom should wear gowns provided for the purpose.

The nurse should wear dresses of material not injured by disinfectants, for these garments, as well as the doctor's gowns, should be disinfected.

The physician, nurses, etc., after being with the patient, should change their clothing before mingling with other persons. After handling the patient or any possibly infected material, the hands of the operator should be washed for a few minutes in carbolic acid solution 1 to 40, bichlorid of mercury 1 to 1,000, or some other disinfectant solution. The floor of the sickroom should occasionally be dampened with one of these solutions.

In cleaning the sickroom the raising of dust should be guarded against by using a damp cloth or mop for the purpose, or by dampening the floor before sweeping it.

By applying a bland oil, such as vaseline, to the surface of the skin of the patient during the stage of desquamation, the dissemination of the exfoliated particles of skin, crusts, etc., may be largely prevented.

Remember that smallpox is infective during the entire period of desquamation and that the patient should be treated accordingly. When the patient is able to be up and desquamation is fairly well along the body of the patient may be sponged daily with a 1 to 2,000 solution of bichlorid of mercury. The patient should then occupy another room, at least until the original sickroom can be disinfected. To do this, everything in the room should be left *in situ* and formaldehyd gas applied by one of the methods already described, preferably by the formalin-permanganate method. In rural districts where formalin is not available sulphur dioxid (pot method) may be used as described on page 15. Sulphur dioxid, however, is rather difficult to confine to one room.

After the gaseous disinfection is completed the floor, tables, chairs, etc., should be washed with a 3 per cent solution of carbolic acid or some other disinfectant solution. The mattress should be burned and the bed linen, garments, and other articles in the room disinfected, as has already been stated.

Any room that may be occupied by the patient during the stage of desquamation should, when vacated, be disinfected in accordance with the rules that have been outlined above.

When the stage of desquamation is entirely over—that is, when the skin is smooth and scales or particles of skin are no longer being given off, even from the pocks of the scalp—the entire house should be disinfected with formaldehyd gas.

After the disinfection is over the room last occupied by the patient should be further treated, as has been stated.

Of course, if the patient dies or is sent to a hospital, the room and entire house from which the patient is removed should be thoroughly disinfected in accordance with the rules outlined to be carried out after the patient's recovery.

SCARLET FEVER.

Scarlet fever is a highly communicable disease, but the nature of the specific organism or cause is not yet known. The infection is likely contained in the secretions of the nose and mouth, and certainly in the exfoliated particles of skin. Desquamation is often so extensive in this disease that it amounts almost to a complete peeling of the outer layers of the skin. The infection seems to live more or less indefinitely in the exfoliated particles of skin, and the disease is often in this way conveyed from the sick to healthy persons.

Scarlet fever is very analogous to smallpox from the standpoint of conveyance, prophylaxis, etc. Therefore, omitting the subject of vaccination, what has been outlined with regard to preventive measures, management, disinfection, etc., for smallpox apply almost equally well to scarlet fever. The reader is consequently referred to the subject of smallpox for many of the details omitted here.

The patient should be isolated in a similar manner and the same precautions taken as have been stated for smallpox. All soiled linen, towels, bedclothes, etc., eating utensils, urine, feces, sputum, and nasal secretions should be disinfected; and the same care of the hands and of the floor, the same precautions as to the doctor's gowns and the nurse's wearing apparel should be taken as have been already outlined above for smallpox.

Remember that it is during the desquamatory or peeling stage of scarlet fever that the disease is most dangerously communicable, and that this condition exists until the stage of desquamation is entirely completed. During this stage the body of the patient should be daily sponged with a 1 to 100 carbolic or a 1 to 2,000 bichlorid solution. In children, however, the use of carbolic acid solution is not entirely free from danger.

Disinfection of the room, bedding, etc., during the stage of desquamation, and disinfection of the entire building, room, and bedding, etc., after desquamation is over should be carried out as in the case of smallpox.

The floor of the sickroom should not be swept in a manner that will raise the dust, as the infection may thus be spread. Either dampen the floor or use a damp mop or cloth for cleaning it.

MEASLES.

Measles is a communicable disease the cause of which is unknown. It usually occurs in epidemic form. The infection is present in the secretions and in the skin, and there seems to be no doubt but that it is present in the secretions of the nose and mouth very early in the disease.

Direct contagion is common, but dried particles of skin, sputum, and nasal secretion containing the infection may be conveyed in dust, clothing, etc., and thus spread the disease. Measles is, therefore, spread in very much the same manner as smallpox and scarlet fever. Consequently the disinfection for measles is the same as that described for smallpox, to which the reader is referred.

Attention is called to the fact that measles being a very common disease, it is not often deemed necessary to take the precautions of isolation and disinfection for measles that are taken for smallpox

and scarlet fever; but it should be borne in mind that in the United States measles causes more than twice the number of deaths caused by smallpox in the same length of time.

CHICKEN POX.

The cause of chicken pox is unknown, but it is undoubtedly due to a specific infection.

The disease is highly " contagious " in the same sense that smallpox is, viz, by contact between the sick and the well. The disease is spread in much the same way and through about the same channels that smallpox spreads, and therefore the same disinfection measures that apply to smallpox apply also to chicken pox.

ERYSIPELAS.

Erysipelas is communicable and is caused by the *Streptococcus erysipelatis*. The organism is contained in the pus and secretions from the seat of the inflammation, and also in the desquamating skin of those suffering with erysipelas.

It is not definitely known how the infection enters the system, but probably it is through the abraded skin or mucous membranes; at least, persons with wounds or abrasions of the skin are very susceptible to infection with erysipelas.

Patients suffering with erysipelas should be isolated and the disinfection measures for erysipelas carried out along the same general lines as have already been prescribed for scarlet fever.

(3) DIPHTHERIA—EPIDEMIC CEREBROSPINAL MENINGITIS—ACUTE ANTERIOR POLIOMYELITIS—INFLUENZA—PNEUMONIA.

DIPHTHERIA.

Diphtheria is a communicable disease caused by the *Bacillus diphtheriæ*. The germ is found in the secretions of the mouth, nose, and throat, and in the membrane from the site of the lesion in diphtheria. It may sometimes be found in the throats of persons showing no signs of the disease. It is not found in the air unless particles of secretions, membranes, etc., after drying, are blown about with the dust. The infection may be directly communicated from mouth to mouth by kissing, coughing, etc., or indirectly by objects that have become contaminated with the germs of the disease. It may also be spread by food, especially milk.

The uses of antitoxin in the prophylaxis and treatment of diphtheria will not be discussed.

Isolation.—Isolation of diphtheria should be carried out as prescribed for smallpox.

Disinfection.—The germ being contained in the secretions of the nose, mouth, and throat, it is obvious that these secretions should be disinfected as soon as eliminated, and that cloths, handkerchiefs, etc., used to receive them should be disinfected or burned. Bed and body linen of the patient, when removed or soiled, should be immersed for one hour in one of the following solutions: Carbolic acid, 5 per cent; formalin, 5 per cent; and tricresol or lysol, 2 per cent. The immersion in the formalin solution can not be done in the sick room. Eating utensils, medicine glasses, etc., used by the patient should be disinfected in boiling water. The thermometer, except when in use, should be kept in a 3 per cent solution of carbolic acid. Brushes, swabs, etc., used about the patient's mouth should, when not in use, be kept in a weak (1 per cent) carbolic acid solution, and when no longer required they should be burned.

Before disposing of feces or urine, they should have added to them, and allowed to stand for at least an hour, an equal volume of one of the following: A 5 per cent solution of carbolic acid, or a solution of chlorinated lime, 4 ounces to the gallon of water.

The hands of attendants, after handling the patient or any material connected therewith, should be washed in a 1 to 40 solution of carbolic acid or a 1 to 1,000 solution of bichlorid of mercury.

Upon convalescence of the patient the entire house should be disinfected with formaldehyd gas, preferably by the formalin-permanganate method. The room in which the patient was sick should then be washed with a disinfectant solution, the mattress burned, and the bedding, etc., either disinfected as described above or boiled or burned.

The *Bacillus diphtheriæ* often exists in the throat for some time after convalescence; therefore, the patient should be kept isolated until bacteriological examinations no longer show the presence of the diphtheria organisms in the throat.

EPIDEMIC CEREBROSPINAL MENINGITIS.

This is a communicable disease caused by the *Diplococcus intracellularis meningitidis*. The organism is found in the cerebrospinal fluid and in the nasal secretions. It is possible that it is sometimes contained in the sputum, urine, and feces.

The methods of conveyance of epidemic cerebrospinal meningitis are not yet definitely settled, but it seems very likely that it and diphtheria are communicated in very much the same way. The measures of isolation, disinfection, etc., prescribed above for diphtheria apply and should be enforced against meningitis.

ACUTE ANTERIOR POLIOMYELITIS.

This disease is also known as "epidemic poliomyelitis" and "infantile paralysis." The cause of the disease is unknown, and it has only recently been definitely proven to be a communicable disease. It may occur in epidemic form. The infection is undoubtedly contained in the nasal secretion and probably in the sputum, urine, and feces of those having the disease.

The way in which the infection is communicated from sick to healthy persons is not well established, but it probably takes place in much the same manner as in the case of diphtheria and epidemic cerebrospinal meningitis; and therefore the same preventive measures should be rigidly carried out against it that have been prescribed for the two latter-named diseases.

INFLUENZA.

Influenza is a highly communicable disease, occurring in widespread epidemics and caused by the *Bacillus influenzæ*. The organism is found in great numbers in the secretions of the nose and mouth of those suffering with the disease. The preventive measures for influenza should be carried out along the same lines as those prescribed for diphtheria.

PNEUMONIA.

Pneumonia, croupous or lobar pneumonia, is a communicable disease. It is caused by the *Diplococcus pneumoniæ*. The organism is widespread and is often found in the sputum of healthy persons. The sputum and nasal secretions of those suffering with the disease contain the organism in enormous numbers. It is therefore obvious that the disease may be communicated in very much the same way that diphtheria is communicated, and that, from a prophylactic standpoint, it should be handled accordingly.

(4) TUBERCULOSIS—LEPROSY.

TUBERCULOSIS.

Tuberculosis is a communicable disease prevalent in all parts of the world.

It is caused by the *Bacillus tuberculosis*, a very minute organism or bacterium. Tuberculosis may affect any part of the human body, although the lungs and respiratory tract are the parts most frequently affected, in which case the disease is often called "pulmonary tuberculosis," "consumption," etc. This is the variety of the disease that is the most dangerously communicable and therefore the one that will be especially considered here.

The bacillus of tuberculosis is usually contained in the sputum of consumptives in large numbers. It is very often contained in the nasal secretion and feces and sometimes in the urine. The germs of tuberculosis outside the body are long-lived and resistant to destruction. It is obvious, then, that the germs may be scattered far and wide by the constant coughing and spitting attending consumption. The dried secretions containing the organisms may mix with the air and dust and thus be inhaled into the lungs of healthy persons.

The germs may also be communicated in many other ways, as, for instance, in the common use by healthy persons and consumptives of drinking cups or glasses, towels, tableware, soap, eating utensils, beds, berths, etc.; from mouth to mouth by kissing or coughing; through the food, especially milk and meat from tuberculous animals; and by the association or living of healthy persons with consumptives. It is largely by means of the sputum in the moist condition that a consumptive infects another person.

Isolation.—A consumptive should be isolated, though not necessarily in the strict meaning of the term as applied to smallpox or scarlet fever. The patient should sleep alone, whether it be in a room, a tent, or in the open. If a room is used, it should be one that is isolated as much as possible from the remainder of the building. It should preferably be on the sunny side of the house and well ventilated. Consumptives that are able to be up and around should spend their time, as far as possible, in the open air, but when indoors they should occupy their own rooms. The consumptive's room should be frequented only by those having duties to perform therein.

Disinfection.—Be careful to *destroy all the sputum of consumptives.* The germ of tuberculosis is easily killed by heat, but it is rather difficult to kill it with chemical disinfectants, especially when it is incorporated with sputum. Therefore the sputum from a consumptive should, as far as possible, either be burned or boiled.

Portable spit cups that are destructible and cheap should be used by consumptives, and after a cup has been in use a few hours it should be burned. If indestructible cups are used, they should contain, while in use, a small quantity of a 5 per cent solution of carbolic acid or a solution of chlorinated lime, and they should be disinfected each day by boiling them and their contents in water. The same measures should be carried out with regard to spittoons, whether they are used by the consumptive or by the public. The spitting in public spittoons by consumptives should be prohibited, but as a matter of fact it often occurs. Consumptives should expectorate only into their own private cups or into the fire. During the act of coughing consumptives should hold a handkerchief before the mouth in order to catch the particles of sputum expelled.

Napkins, handkerchiefs, clothes, etc., used by consumptives should be disinfected in boiling water. Eating utensils, drinking cups, medicine glasses, etc., should also be disinfected in actually boiling water, and under no conditions should they be used by healthy persons until they have been disinfected. Consumptives should never use public drinking cups.

Bed and body linen removed or soiled by the consumptive should be placed directly into a kettle of water and boiled; if this is not practicable at the time of removal they should be placed in a 5 per cent solution of carbolic acid or a 2 per cent solution of tricresol or lysol until such time as they can be boiled.

As the feces of consumptives usually contain the germs of tuberculosis in large numbers, the fecal discharges of consumptives should be disinfected in accordance with the same general rules as have been prescribed for the stools in typhoid fever.

The floor of a consumptive's room should occasionally be mopped with a disinfectant solution. The floor should *never* be swept without guarding against the raising of dust; either dampen the floor before it is swept or use damp mops or cloths for cleaning it.

Consumptives, when not confined to the bed, should occasionally wash their hands in a disinfectant solution, such as 2.5 per cent carbolic acid or 1 per cent tricresol or lysol. After handling a consumptive or any infected material the hands of the attendant should be washed in one of the solutions just mentioned.

Upon the permanent vacation of the quarters occupied by a consumptive, whether through death, removal, or recovery, the room, and preferably the entire building, should be disinfected with formaldehyd gas, as described on page 9. The ingredients for producing the gas not being available, sulphur dioxid (pot method) should be used. The treatment of the room, bedding, etc., following the gaseous disinfection should be as has been prescribed for smallpox.

LEPROSY.

Leprosy is a communicable disease caused by the *Bacillus lepræ*. It is not as highly communicable as tuberculosis, but in many other ways the two diseases are very analogous. The germs of leprosy are contained in the lesions of leprosy in enormous numbers, and therefore they are being continually thrown off with the scales, discharges, etc., from the lesions of those suffering with the disease. The nasal secretions of lepers usually contain the germs in large numbers, and consequently many of them are eliminated from the body in these secretions.

The way in which the disease is communicated from the leper to the nonleper is not well understood, but it has been observed that a

nonleper sometimes contracts the disease after having lived or associated with a leper.

There is no doubt that lepers should be segregated, but ample provision should be made for their maintenance and comfort. The same thing said of tuberculosis would undoubtedly hold true were it possible of accomplishment, but the segregation of all those suffering with tuberculosis is, from an economic standpoint, impossible.

The principles of disinfection for leprosy should be carried out along the same lines as for tuberculosis, which it so closely resembles, particular attention being paid to the nasal secretions. The Leprosy Investigation Station [1] has found a nasal spray of value in freeing the nasal discharges from the bacilli. The nasal cavity is sprayed three times a day with acetozone inhalant (acetone 1 per cent, chlorotone 0.5 per cent in liquid petrolatum).

(5) PLAGUE—TYPHUS FEVER—YELLOW FEVER—MALARIA—DENGUE.

PLAGUE.

Plague, also called bubonic plague, black death, etc., is a communicable disease caused by the *Bacillus pestis*. Patients suffering with plague may give off the germs of the disease in all the discharges from the body, but especially in the sputum and feces. Plague is communicated largely through the agency of insects, particularly fleas, bedbugs, lice, etc. Rats, mice, squirrels, guinea pigs, monkeys, cats, etc., are susceptible to the disease; and among rats, mice, and squirrels it may occur in fatal epidemic form.

Fleas become infected by feeding on the blood of plague-sick animals, after which they may carry the infection either to other animals or to human beings. Fleas are largely responsible for the transmission of plague, but it may also be transmitted by bedbugs, lice, flies, etc. Although an unsettled question, it is possible that plague infection may be communicated to man through food that has been contaminated by plague-infected rats or insects.

The principal disseminators of plague infection, then, are *rats*, indirectly by having the disease and harboring fleas, which carry the infection from rat to rat; and, second, *fleas* directly by becoming infected from plague-sick rats or humans and carrying the infection to healthy persons.

Isolation.—Plague should be isolated in the same manner as has been prescribed above for the isolation of smallpox.

Disinfection.—Disinfection in plague prevention is directed largely toward the destruction of rats, mice, fleas, bedbugs, flies, and other

[1] "Studies upon leprosy (a palliative treatment for leprous rhinitis." By James T. Wayson and A. C. Reinecke.) Public Health Bulletin No. 33, United States Public Health & Marine-Hospital Service, Washington, 1910, p. 15.

animals and insects that may transmit the infection. Rats, mice, squirrels, etc., in a plague-infected territory should be exterminated as completely as possible. Use sulphur dioxid, traps, poison, etc., and as soon as the animals are killed they should be burned. The floor of the sick room of a plague patient should be sprinkled occasionally with pyrthrum powder in order either to kill the fleas and other insects or to keep them away from the patient. Sweepings from the room should be burned. Sputum feces, urine, and other discharges from the patient should be disinfected with one of the following solutions: Five per cent carbolic acid, 5 per cent formalin, 2 per cent tricresol, or lysol, chlorinated lime, etc. Soiled bed linen, towels, handkerchiefs, and other objects that have come in contact with the patient should be disinfected by immersion in one of the disinfectant solutions just mentioned or by boiling. The hands of the nurse should be washed in a solution of carbolic acid or bichlorid of mercury.

Upon the termination of the disease the room should be liberally sprinkled with pyrethrum and then fumigated with sulphur dioxid as an insecticide (see p. 24). Following this fumigation, the mattress should be burned, the bedclothes, etc., burned or boiled, and if any lice or bedbugs are present they should be killed, either with boiling water, gasoline, or in some other way.

TYPHUS FEVER.

Typhus fever, also known as spotted fever, jail fever, ship fever, *tabardillo*, etc., is a communicable disease, the cause of which is unknown. The disease is conveyed by the body louse, *Pediculus vestimenti*.[1] The louse, by biting a patient suffering with typhus fever, becomes infected, and it may then transfer the infection to healthy persons by biting them.

Patients suffering with typhus fever should be isolated lest healthy persons entering the sick room become infested with infected lice.

Disinfection.—The preventive measures should be rigidly carried out toward the destruction of the louse. When a case of typhus fever is discovered the patient's clothing should be removed and immediately boiled or placed in a 1 to 500 bichlorid of mercury solution in order to kill the lice and their eggs. Another bed should be provided for the patient and the framework of the one just vacated should be scalded with boiling water or the lice killed in some other way. The mattress should be burned, and the bed clothing boiled or placed in a 1 to 500 bichlorid solution. Parts of the room likely to harbor lice should be scalded with boiling water. The patient's

[1] Public Health Reports, vol. 25, Feb. 18, 1910, p. 177.

hair should be clipped and the clippings burned. The patient should then be given a thorough sponging with a 1 to 1,000 solution of bichlorid of mercury. The discharges from the patient are not thought to contain the infection of typhus fever; therefore their disinfection is thought to be unnecessary.

Following the removal of the patient from the room, the mattress, bed clothing, etc., should be treated as above stated, and then the room should be given a thorough fumigation with sulphur dioxid, as has been prescribed for the destruction of lice. Following the fumigation, the framework of the bed, the floor, walls, etc., of the room should be soaked with boiling water or saturated with petroleum, gasoline, or some other method of killing lice enforced. The use of petroleum, and particularly of gasoline, is of course attended with danger from fire.

YELLOW FEVER.

Yellow fever is a communicable disease, the cause of which has not yet been discovered. The disease is transmitted by the bite of a mosquito, the *Stegomyia calopus*. In order for this mosquito to transmit the disease it is necessary that it be infected by biting a human case of yellow fever. About 14 days after thus becoming infected, it may transmit the disease to nonimmune persons by biting them; this it may do during the remainder of its life. It is only in the manner just stated that yellow fever is transmitted from sick to healthy persons.

Yellow-fever patients should be isolated on account of the possibility of their quarters harboring infected mosquitoes.

The preventive measures against yellow fever consist of screening the patient and the destruction of the mosquito. The patient, therefore, should be kept in a well-screened room and, as a further precaution, in a bed covered with mosquito netting.

Following the removal of the patient, the room, and preferably the entire building, should be fumigated with sulphur dioxid, as described for the destruction of mosquitoes on page 25. Pyrethrum may be used, but it is not nearly so efficient for killing mosquitoes as is sulphur dioxid.

MALARIA.

Malaria is a communicable disease caused by the *Plasmodium* of malaria. It is transmitted only by the bite of a mosquito of the group known as *Anopheles*. The mosquito becomes infected and transmits the disease in a manner very similar to that described for yellow fever.

Administering quinine, screening the patient, and destroying the mosquito are the preventive measures to be carried out against malaria. However, effective screening of the patient becomes a difficult problem when consideration is given to the widespread prevalence of malaria and to the fact that the mosquito may become infected by biting a case of malaria long after the patient has apparently recovered from the disease.

DENGUE.

Dengue is a communicable disease, the cause of which is unknown, but is transmitted by the bite of a mosquito, the *Culex fatigans*. This mosquito may transmit the disease to nonimmune persons by biting them almost immediately after the mosquito has fed on the blood of a patient suffering with dengue.

As to how long the mosquito after becoming infected is capable of infecting nonimmune persons is not known.

The measures for preventing dengue should be carried out in the same manner as they are carried out in the case of yellow fever.

LIST OF PUBLIC HEALTH BULLETINS.

The following is a list of the public health bulletins that have been issued. Beginning with No. 32 they have been numbered on the cover, the previous editions having been numbered arbitrarily. Copies of those available for distribution may be obtained by addressing the Surgeon General, Public Health and Marine-Hospital Service.

*1. Report on Trichinæ and Trichinosis. By W. C. W. Glazier. 1881. 212 pages. 87 il. 1 map. Paper. Senate Executive Document No. 9, Forty-sixth Congress, third session. Out of print.

*2. Report on the Etiology and Prevention of Yellow Fever. By George M. Sternberg. 1890. 271 pages. 21 pl. 20 il. Cloth. Out of print.

*3. Mortality Statistics in the United States for the Year ending December 31, 1897. From Annual Report Marine-Hospital Service, 1898. 24 pages. Paper.

4. Yellow Fever: Its Nature, Diagnosis, Treatment, and Prophylaxis and Quarantine Regulations Relating Thereto. By officers of the Marine-Hospital Service. Reprint from Annual Report Marine-Hospital Service, 1898. 176 pages. 1 il. Paper.

*5. Shipment of Merchandise from a Town Infected with Yellow Fever. By H. R. Carter. 1899. 15 pages. Paper. Out of print.

6. Report of Commission of Medical Officers Detailed by Authority of the President to Investigate the Cause of Yellow Fever. By Eugene Wasdin and H. D. Geddings. July, 1899. 98 pages. 26 charts. 2 il. Paper.

*7. The Bubonic Plague. By Walter Wyman. January, 1900. 50 pages. Paper. Superintendent of Documents, 5 cents.

*8. Report of Commission appointed by the Secretary of the Treasury for the Investigation of Plague in San Francisco. By Prof. Simon Flexner, Prof. F. G. Novy, and Prof. L. F. Barker. January 23, 1901. 23 pages. 1 map. Paper. Out of print.

*9. Report Relating to the Origin and Prevalence of Leprosy in the United States. By a Commission of Medical Officers of the United States Marine-Hospital Service. 1902. 119 pages. 25 il. Paper. Senate Document No. 269, Fifty-seventh Congress, first session. Superintendent of Documents. Cloth, $1.00.

*10. Plague Conference. Containing a copy of the address of the chairman, and resolutions passed by a conference called in accordance with requests from a number of State Boards of Health, and under authority of section 7, act of Congress approved July 1, 1902, to consider the plague situation. Reprint from P. H. R. No. 4, Vol. XVIII, January 23, 1903. 9 pages. And February 6, 1903. 41 pages. Paper. Out of print.

*11. Transactions of the First Annual Conference of State and Territorial Health Officers with the United States Public Health and Marine-Hospital Service. June, 1903. 120 pages. Cloth.

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* Exhausted and not for distribution.

12. Transactions of the Second Annual Conference of State and Territorial Health Officers with the United States Public Health and Marine-Hospital Service. June, 1904. 95 pages. Cloth.
13. The Public Health and Marine-Hospital Service of the United States. A Brief History. Prepared for the Louisiana Purchase Exposition. December, 1904. 16 pages. Paper.
*14. Sanatorium for Consumptives, Fort Stanton, N. Mex. By P. M. Carrington. Reprint from Annual Report Public Health and Marine-Hospital Service, 1904. 19 pages. Paper. Out of print.
15. Transactions of the Third Annual Conference of State and Territorial Health Officers with the United States Public Health and Marine-Hospital Service. May, 1905. 52 pages. Cloth.
16. How to Prevent Yellow Fever—No Mosquitoes, No Yellow Fever. By Walter Wyman. July 31, 1905. 3 pages. Circular.
17. Transactions of the Fourth Annual Conference of State and Territorial Health Officers with the United States Public Health and Marine-Hospital Service. May, 1906. 75 pages. Cloth.
18. Transactions of the Fifth Annual Conference of State and Territorial Health Officers with the United States Public Health and Marine-Hospital Service. May, 1907. 47 pages. Cloth.
19. Trachoma. Its Character and Effects. By Taliaferro Clark and J. W. Schereschewsky. 1907. 34 pages. 6 il. Paper.
*20. The Public Health and Marine-Hospital Service of the United States. A Brief History. Prepared for the Jamestown Ter-Centennial Exposition. 1907. 12 pages. Paper. Out of print.
21. Transactions of the Sixth Annual Conference of State and Territorial Health Officers with the United States Public Health and Marine-Hospital Service. April, 1908. 79 pages. Cloth.
*22. The Present Pandemic of Plague. By J. M. Eager. 1908. 30 pages. Paper. Out of print.
23. Pellagra—A Precis. By C. H. Lavinder. July 24, 1908. 22 pages. 1 il. Paper.
24. The Marine-Hospital Sanatorum, Fort Stanton, N. Mex. Prepared for the International Congress on Tuberculosis, held in Washington, September, 1908. 32 il. 56 pages. Paper.
*25. Hookworm Disease. Reprint from Annual Report Public Health and Marine-Hospital Service, 1908. 5 pages. Paper. Out of print.
26. Studies upon Leprosy.
    I. The Present Status of the Leprosy Problem in Hawaii.
    II. The Reaction of Lepers to Moro's "Percutaneous" Test.
    III. A Note Upon the Possibility of the Mosquito Acting in the Transmission of Leprosy. By W. R. Brinckerhoff. 1908. Investigations made in accordance with the act of Congress approved March 3, 1905. 24 pages. Paper.
27. Studies upon Leprosy.
    IV. Upon the Utility of the Examination of the Nose and the Nasal Secretions for the Detection of Incipient Cases of Leprosy. By W. R. Brinckerhoff and W. L. Moors. 1909. Investigations made in accordance with the act of Congress approved March 3, 1905. 29 pages. Paper.

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* Exhausted and not for distribution.

28. Studies upon Leprosy.
    V. A Report upon the Treatment of Six Cases of Leprosy with Nastine (Deycke). By W. R. Brinckerhoff and J. T. Wayson, Honolulu, T. H.
    VI. Leprosy in the United States of America in 1909. By W. R. Brinckerhoff. 1909. Investigations made in accordance with the Act of Congress approved March 3, 1905. 25 pages. Paper.
29. The Prevalence of Rabies in the United States. By J. W. Kerr and A. M. Stimson. 1909. 16 pages. Paper.
30. The Rat and its Relation to the Public Health. By various authors. 1910. 254 pages. 60 figs. 6 pls. Paper.
    1. Introduction. By Walter Wyman.
    2. Natural History of the Rat. By D. E. Lantz.
    3. Plague Infection in Rats. By G. W. McCoy.
    4. Rat Leprosy. By W. R. Brinckerhoff.
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    6. Organic Diseases of the Rat. By G. W. McCoy.
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    17. The Rat in Relation to International Sanitation. By J. W. Kerr.
31. Transactions of the Seventh Annual Conference of State and Territorial Health Officers with the United States Public Health and Marine-Hospital Service. June, 1909. 86 pages. Cloth.
32. Hookworm Disease (or Ground-Itch Anemia), its Nature, Treatment, and Prevention. By Prof. C. W. Stiles. 1910. 40 pages. Paper.
33. Studies upon Leprosy. 1910. 25 pages. Paper.
    VII. A Statistical Study of an Endemic Focus of Leprosy. By W. R. Brinckerhoff and A. C. Reinecke.
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39. Studies upon Leprosy. September, 1910. 50 pages. Paper.
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    X. Flies in Relation to the Transmission of Leprosy. By D. H. Currie.
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40. Transactions of the Eighth Annual Conference of State and Territorial Health Officers with the United States Public Health and Marine-Hospital Service. November, 1910. 101 pages. Paper.
41. Studies upon Leprosy. November, 1910. 32 pages. Paper.
    XII. Notes on the Study of Histories of Lepers from the standpoint of Transmission. By D. H. Currie.
    XIII. A contribution to the Study of Rat Leprosy. By D. H. Currie and H. T. Holman.
42. Disinfectants, Their Use and Application in the Prevention of Communicable Diseases. By T. B. McClintic. December, 1910.